THE EYE OF THE SAHARA HYPOTHESIS

A Predictive Model & 25 Element Testing Protocol for Predynastic Sahara Migration

Zep Tepi Series, The Corridor — Paper I

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Abstract

> *"O Atum-Kheprer, you were on high on the primeval hill… you rose up as the benben stone in the mansion of the Benu-bird."*
>
> — Pyramid Texts, Utterance 600 (Mercer 1952; cf. Faulkner 1969)

This is one of the oldest surviving descriptions of creation in Egyptian religious tradition: a mound rising above the waters. Every major Egyptian temple from Heliopolis onward was understood to stand on this same primeval mound (Reymond 1969), repeated across two and a half thousand years of practice. This paper asks whether that recurring image could preserve, alongside its cosmological meaning, a memory of a real landscape: what physical shape would such a landscape need, and does one exist in the Sahara? Known facts — climate, genetics, isotopes, geology, botany, iconography, archaeology — test which location, if any, plausibly matches, narrowing from every known candidate only as far as the evidence allows.

Predynastic Egypt (c. 3800–3100 BCE) shows converging anomalies that a purely local development model cannot explain: hard-stone vessels whose material provenance remains unresolved, the ancient quarry sites for the diorite varieties being unknown and Egyptian basalt sources indistinguishable in thin section (Aston 1994: 20–21); ~78–80% North African Neolithic ancestry in an Old Kingdom genome, modelled as predominantly Middle Neolithic Moroccan (Morez Jacobs et al. 2025); and a textual/iconographic record naming a western people, the ṯḥnw (Tehenu), as a documented point of contact (Ciałowicz 2001; O'Connor 1990; Silvestri 2023). This paper tests whether a single migration event, driven by the termination of the African Humid Period (~5,500 BP), accounts for these anomalies together, and whether a specific candidate landscape survives elimination against every other known formation of comparable type.

Elimination proceeds in independent stages: sufficient scale to support a population; documented Holocene water; documented physical evidence of human presence at the structure during that window; and a central elevation rising from that water. The surviving candidate is then tested against three further, independent lines: botanical material attested in Egypt before unification yet absent from Egypt's own flora; an iconographic motif tracked from that candidate into Predynastic Egyptian material culture; and a geochemical signature tested against the vessels' own measured composition, with the resulting rock colors examined only afterward, as a consequence, not a criterion.

***Keywords**: Predynastic Egypt; Naqada culture; African Humid Period; Sahara; archaeogenetics; strontium isotope analysis; hard-stone vessels; Tehenu; Richat Structure; Zep Tepi; human migration; North Africa prehistory; Canopus; Wedjat; Eye Of Horus*

Author's Note

I am not an academic or a scientist. I hold no institutional affiliation and no formal training in any of the fields this paper draws on — paleoclimatology, archaeogenetics, isotope geochemistry, archaeology, or geology. What I have is time, persistence, and a willingness to be told I am wrong.

This document assembles existing, published research — climate science, genetics, archaeology, geology — from peer-reviewed sources. The climate scientists published the dust records. The geneticists published the genomes. The archaeologists published the stone vessels and the rock art. They worked in different journals, for different audiences, asking different questions. No one asked them to look at each other's work. I followed the trail where it led — across fields, across time, across the Sahara. I did not generate new data. I assembled existing data in order and let the pattern emerge.

AI tools assisted throughout this work — for literature search, drafting, and citation verification — and are disclosed in full in the References. No single tool was trusted on its own; every citation here has been checked against its actual source, because every one of these tools has, at some point in this project, produced a confident answer that did not survive that check.

This is not a report of findings. It is a predictive model: a specific, falsifiable hypothesis about where to look for answers. Direct archaeological investigation of the candidate landscape identified in this paper is not currently possible. But the tests proposed here — geochemical, genetic, isotopic — can be run today, on samples that already exist in museum collections.

The pattern led to a place I did not expect: a geological formation in Mauritania whose geology matches, in composition, the hard-stone vessels that appear abruptly in Predynastic Egypt with no clear local developmental sequence. It led to a question: what if the people who made those vessels came from the west?

I do not know the answer. But I know the evidence exists. I know the vessels sit in museum collections, largely untested. I know the geology of the candidate region is unusual. I know the tests are straightforward.

If you read this and find it compelling, I am not asking you to believe me. I am asking you to look. To test the stone. To run the isotopes. To give us an answer, one way or the other. If it is no, I will take it. I would rather be wrong and know than wonder if I am right. But if it is yes, then we have found something real — something that changes how we understand the origins of Egyptian civilization.

That is all I ever wanted. Just to know.

Introduction

Egyptian religious tradition assigns a name to the moment of creation: Zep Tepi, the First Time. It is not a minor or peripheral concept. It appears in the Pyramid Texts, the oldest substantial body of Egyptian religious writing (from c. 2350 BCE, though drawing on older oral material); it recurs through the Coffin Texts of the Middle Kingdom; and it is still being invoked in temple building

inscriptions two thousand years later, in the Ptolemaic period. Whatever this tradition is, it was never allowed to lapse.

Across all of these sources, the content of the tradition is remarkably stable. Before the ordered world existed, there was only Nun — an infinite, undifferentiated primeval water. Out of that water, a single mound of land rose and became solid ground: the first place, the first act of creation, the point from which everything else followed. Pyramid Texts Utterance 600 states this directly, describing the primeval hill and the moment the creator god “rose up” upon it as the benben stone. Every major Egyptian temple that followed — Heliopolis, and every temple modeled on it — was understood by its own priesthood to physically stand on this same mound, re-enacting the moment of creation in stone (Reymond 1969). This is not one temple's private myth. It is the shared architectural theology of Egyptian religion for the whole of its recorded history.

The conventional scholarly treatment of this material is cosmological: a symbolic account of order emerging from chaos, with no claim to describe an actual, locatable place. That reading is defensible and remains the default in Egyptological literature. This paper starts from a different, narrower question, without disputing that default reading as the correct one for the text's own purpose. Oral and religious traditions elsewhere have been shown, on independent physical evidence, to preserve real geographic and environmental information across spans of time far longer than intuition would suggest is possible. Aboriginal Australian oral traditions describing coastlines and landmarks since submerged by post-glacial sea-level rise have been checked against the actual bathymetry and radiocarbon chronology of the relevant coastline, and found to match real events more than 7,000 years old (Nunn & Reid 2016) — a tradition considerably older, relative to living memory, than the gap this paper is testing. The existence of that precedent does not prove Egyptian creation tradition preserves anything real. It establishes only that dismissing a recurring, stable, millennia-old image as pure invention, without checking whether a real landscape could have produced it, is not the only responsible scholarly position available.

This paper takes the second position as a working method, not a conclusion. It asks what a real mound-rising-from-water landscape would need to look like, physically, to have plausibly generated this specific tradition, and then tests every known candidate in the Sahara against that physical description — together with every other line of independent evidence, climatic, genetic, isotopic, botanical, geochemical, iconographic, and archaeological, that bears on the same question. If no landscape survives that testing, the tradition remains what the conventional reading already says it is: cosmology, not geography. What follows is that test.

1. The Empirical Problem

The standard account of early Egypt is one of local continuity: villages along the Nile grew into towns, techniques developed gradually, and a state emerged from within that gradual development. Several findings from the Predynastic record do not fit that account cleanly.

The first is technological. Sometime around 3800–3500 BCE — the Naqada I–II period — Upper Egyptian craftsmen begin producing vessels from hard stone: breccia, andesite, quartzite. Earlier Egyptian stone vessels use soft materials — limestone, alabaster — worked with techniques attested for centuries beforehand. The provenance of the hard stones themselves, however, is only partly resolved. Aston records that in the Predynastic Period, particularly for hard stones,

exploitation appears to have focused on loose blocks already detached from the rock mass rather than on direct quarrying of bedrock, that the specific ancient quarry sites for the varieties of diorite are not known, and that the different Egyptian basalt outcrops cannot be distinguished in thin section — leaving it, in her words, impossible to say whether the basalt for vessels found at Upper Egyptian sites such as Naqada and Diospolis derived from Gebel Qatrani (Aston 1994: 20–21). Provenance is by contrast secure for one major vessel stone: the anorthosite gneiss used primarily for Predynastic and Early Dynastic funerary vessels was quarried at Gebel el-Asr in Lower Nubia, some 65 km north-west of Abu Simbel (Shaw et al. 2001). The gap is therefore specific rather than general, and it is a gap in method as much as in evidence: thin-section petrography cannot separate these sources, whereas trace-element, rare-earth and Sr-Nd isotopic analysis can. That is the test proposed in Category 1 below. The vessels appear in elite graves from their earliest occurrence, already technically accomplished.

The second is biological. Ancient genomes are now available from three geographically independent North African nodes (Salem et al. 2025; Lipson et al. 2025; Morez Jacobs et al. 2025), documenting a distinct North African lineage present across the region through the period in question, and the first whole genome from an Old Kingdom Egyptian is modelled with the majority of its ancestry deriving from North African Neolithic populations (Morez Jacobs et al. 2025). No strontium or oxygen isotope study of Predynastic Hierakonpolis remains has been published, and none is claimed here; the biological case rests on genomic evidence alone. Such an isotopic study is stated below as a falsification test.

The third is genomic. Morez Jacobs et al. (2025) sequenced the genome of an early Old Kingdom individual from Nuwayrat (c. 2855–2570 BCE). The result: 77.6% ± 3.8% of his ancestry is modeled as Middle Neolithic Moroccan (the Skhirat-Rouazi population, "Morocco_MN"), with the remainder tracing to Neolithic Mesopotamia. Isotopic testing of the same individual confirms he grew up in the Nile Valley — meaning the North African ancestry component was already present in a Nile Valley population by this date, not a signature of recent immigration within this individual's own lifetime.

None of these findings requires the others to be real. Each is independently published, independently peer-reviewed, and independently explicable in isolation. What is harder to explain in isolation is why they converge on the same direction — west — in the same narrow window of time.

The textual and iconographic record of the period offers a further, converging line. The Libyan Palette (c. 3200–3000 BCE) depicts conflict with a named western people, the ṯnw (Tehenu) (Ciałowicz 2001; Baines 1995). Egyptian scribes did not invent this name for a vague or distant population: later texts consistently locate the Tehenu to Egypt's west. Whether this Predynastic-era Tehenu is the same population later identified through historical linguistics as ancestral to, or in sustained contact with, proto-Berber speakers is a separate question: that specific linguistic identification rests on later New Kingdom material (O'Connor 1990; Silvestri 2023), roughly fifteen centuries after the Libyan Palette, and is not itself evidence of continuity across that gap. Proto-Berber itself is reconstructed with deep roots in the Sahara and northwestern Africa, with recent phylogenetic work associating its dispersal with pastoralist expansions temporally aligned to the termination of the African Humid Period, though the precise homeland remains debated (Blench

2019). Rock art across Egypt's Western Desert independently attests to long-term contact between desert and Nile populations predating this period (Darnell 2021).

A trade-only explanation would need to explain, separately and without a shared cause, why the vessels' raw material tradition shows no local antecedent, why several individuals at the same site carry a non-local isotopic signature, why the region's deepest ancestral component two centuries later traces west, and why Egyptian scribes recorded conflict with, and a name for, a real western population in the same period. A migration model explains all of this with a single mechanism. The rest of this paper tests that mechanism directly, and asks whether a specific origin landscape can be identified.

2. The Climate Driver

Between roughly 14,800 and 5,500 years before present, orbital forcing intensified the West African monsoon, pushing the intertropical rain belt hundreds of kilometres north of its present limit. Grassland and seasonal lakes extended from the Atlantic coast to the Nile Valley for nearly ten thousand years — the African Humid Period (AHP). This was not a brief wet interlude between two dry states; it was a stable climatic regime lasting longer than the whole of recorded Egyptian history that followed it (Armstrong et al. 2023).

The termination was abrupt on a geological timescale, though regionally uneven. High-resolution proxy records — speleothem deposits, marine sediment cores, and climate models — place the main termination pulse at approximately 5,500 years before present, c. 3500 BCE (Armstrong et al. 2023; deMenocal et al. 2000). Lowland basins destabilized first; elevated massifs and plateaus retained water and pasture for longer, creating a landscape of shrinking refugia rather than a single, simultaneous collapse.

Kuper and Kröpelin (2006) compiled radiocarbon dates from 150 archaeological excavations across Egypt, Sudan, Libya, and Chad, tracking the Green Sahara's occupation and abandonment directly rather than modeling it indirectly. The resulting chronology is precise: initial settlement following the humid onset by c. 8500 BCE; peak occupation across the entire Sahara from roughly 8500 to 5300 BCE, with dense site distribution across the whole region; from 5300 to 3500 BCE, a "Regionalization" phase marked by retreat to ecological refuges such as the Gilf Kebir plateau and seasonal or episodic transhumance; and from 3500 to 1500 BCE, a "Marginalization" phase in which Southwest Egypt receives only passing visits while occupation in Northern Sudan persists. This is not a model of what should have happened. It is a direct count, across four countries and four millennia, of where dated human occupation exists and where it thins to almost nothing.

In 2006, Kuper and Kröpelin compiled this chronology directly from the archaeological record rather than modeling it. The pattern they found is summarized below.

Period	Event	Evidence
~8500 BCE	Initial settlement after humid onset	Radiocarbon dates from newly occupied sites
8500–5300 BCE	Peak occupation across Sahara	Dense site distribution across entire region
5300 BCE	Beginning of gradual	Abandonment of marginal areas begins

	desiccation	
5300–3500 BCE	Regionalization	Retreat to ecological refuges (e.g. Gilf Kebir); seasonal or episodic transhumance
3500–1500 BCE	Marginalization	Southwest Egypt receives only passing visits; occupation persists in Northern Sudan

A population living through this collapse did not face a single migration event so much as a multi-generational retreat toward whatever water persisted longest. Rather than a single continuous river route, the more plausible pathway is a stepping-stone network of highlands, plateaus, and fossil water sources offering more stable resources as the lowlands dried. Osborne et al. (2008) document trans-Saharan corridors primarily in coastal and lowland contexts, but the same principle of refugia-based dispersal applies to highland terrain, where water and pasture persisted longer during aridification (Drake et al. 2011). A paleoriver system identified through radar and gravimetric analysis (Skonieczny et al. 2015; Klokočník et al. 2017) may have supplemented an eastern segment of this network, though the primary backbone appears to be highland terrain rather than a continuous watercourse — a pattern consistent with documented pastoralist mobility in drying environments generally. PALSAR L-band orbital radar mapping independently confirms the Gilf Kebir plateau as one of three headwater tributaries of the Kufrah paleoriver system, alongside Tibesti and Jabal Uweinat (Paillou et al. 2009), lending direct physical support to this segment of the route. The proposed mechanism unfolds in two phases: initial displacement into intermediate highland refugia (~5,500–5,000 years before present), followed by consolidation and movement toward the Nile Valley (~5,000–4,500 years before present) — a timeline consistent with continuous occupation at the corridor nodes documented above, and with material culture at those nodes showing gradual evolution from Saharan toward Nile-affiliated styles.

A chain of documented AHP-era occupation sites traces a northeast trajectory consistent with this refugia model, each node offering independently verified water, physical evidence of habitation, and a distinct material or symbolic signature. The table below documents this chain in full.

Site	Location	Occupation Window	Key Physical Evidence	Water Source	Key Symbolic Feature
Richat Structure	Mauritania	15,000–8,000 BP	Acheulean & Neolithic tools in Holocene sediments at the structure (Giresse et al. 2012)	Playa lakes with freshwater fossils	Concentric ring geology; teardrop wadi
Tassili n'Ajjer	Algeria	10,000–4,000 BP	>15,000 rock art panels; Round Head to Pastoral transition	Plateau springs and wadis	Cattle herding and ritual scenes
Tadrart Acacus / Takarkori	Libya	8,300–5,000 BP	Stratified deposits; burials; pottery; 7,000 BP genome (Salem et al. 2025)	Rock shelter near ancient lake; groundwater	Early pastoral economy, cattle remains
Messak Settafet	Libya	5,000–3,000 BCE	Highest lithic density worldwide (up to 75 tools/m²); >200 ceremonial platforms	Plateau wadis; fog drip	Concentric-ring ceremonial architecture
Gilf Kebir /	Egypt	8,000–4,000	Hearths; stone	Fossil wadis;	Complex ritual

Wadi Sura		BP	tools; “Cave of Beasts” (>5,000 figures)	aquifer seepage	and cattle imagery
Nabta Playa	Egypt	7,500–5,000 BP	Megalithic stone circle; cattle tumuli; stellar alignments	Seasonal playa lake; groundwater	Astronomical calendar and cattle cult
Hierakonpolis / HK6	Egypt	3,800–3,000 BCE	Elite cemetery; exotic animal burials; non-local isotopic signatures	Nile River and canals	Integration of Saharan pastoral traditions

This paper treats the specific identity of the westernmost node in that chain as a separate, testable question from the corridor's existence, and addresses it directly in the section that follows.

3. First Elimination: Basic Criteria

Before any question of migration route or destination can be meaningfully asked, the origin point itself has to be identifiable by physical criteria independent of any text's own wording. Four criteria were fixed before any candidate was evaluated against them, in this specific order, so that no candidate's inclusion or exclusion could be adjusted after the fact.

First, sufficient physical scale to support a population large enough to originate a lasting cultural tradition — not a temporary camp, but a landscape capable of sustaining people across many generations. Second, independently documented Holocene water at the structure itself, not merely in the surrounding region: without water, no population could have lived there during the Green Sahara at all, regardless of the structure's shape. Third, documented physical evidence that people were actually present at the structure during this window — tool assemblages, occupation deposits, or comparable material — since a landscape that merely could have supported a population is not evidence that one lived there; a source region has to have had people in it. Fourth, and only once the first three are satisfied, a central elevation rising above its surroundings, with evidence of standing or retained water around or within it — the specific physical configuration a mound-rising-from-water tradition would most plausibly encode, tested as geometry, not as a description to be matched.

Every known Saharan formation with a comparable dome, uplift, or crater morphology was evaluated against these four criteria. The results are summarized below.

Formation	Type	Scale	Holocene Water	Human Occupation	Mound
Richat Structure	Alkaline dome	40–50 km	Yes — paleolakes 15,000–8,000 BP (Giresse et al. 2012)	Yes — Acheulean & Neolithic tools in Holocene sediment at the structure (Giresse et al. 2012)	Yes — central uplift, annular water
Tin Bider	Impact crater	Small	No — impact >66 Ma	None documented	N/A
Kebira	Impact crater	31 km	No — impact >66 Ma	None documented	N/A
Aorounga	Impact crater	17 km	No — impact >66 Ma	None documented	N/A
BP Structure	Impact crater	2 km	No	None documented	N/A

Oasis (Bahr)	Impact crater	3 km	No	None documented	N/A
Tenoumer	Impact crater	Small	No — minimal	No sites documented	N/A
Aouelloul	Impact crater	Small	No — minor sediments only	No sites documented	N/A
Talemzane	Impact crater	Small	No — limited	No sites documented	N/A
Amguid	Impact crater	Small	No — minor	No sites documented	N/A
Arkenu	Igneous twin ring	5–8 km	No — undocumented	None documented	No — twin, not single central mound
Jebel Hadid	Igneous ring complex	Regional	No — no documented paleolakes	None documented	Close morphologically; fails on water
Foum Teguentour	Salt diapir	8 km	No — undocumented	No sites documented	No
Mazoula	Reef/salt diapir	<1 km	No — undocumented	No sites documented	No
Tibesti	Volcanic massif	Regional	Regional only, not at structure	Regional only	No — linear, not mound-in-water
Tassili n'Ajjer	Sandstone plateau	Regional	Yes — springs/wadis, real	Yes — extensive	No — plateau, no central dome
Tadrart Acacus	Ridge complex	Regional	Yes — rock shelter near paleolake	Yes — Takarkori	No — linear ridge
Hoggar (Ahaggar)	Volcanic swell	Regional	No — undocumented at structure	Regional rock art only	No — no concentric/mound structure
Aïr Mountains	Scattered granite domes	Regional	Separate paleolake (Seggedim), not integrated	Regional only	No — scattered, not unified mound
Jabal Uweinat	Igneous massif	~50 km	No — hyperarid	Rock art present regionally; none confirmed at structure core	No
Ennedi Plateau	Sandstone tableland	Regional	No — undocumented at structure	Rock art present regionally; none confirmed at structure core	No

Ten of the formations above are impact craters — scars from extraterrestrial collisions, several dating to tens of millions of years before the Green Sahara existed at all. An impact crater can fail the water and scale criteria for a structural reason, not an accident of survey coverage: these are geologically ancient wounds in bedrock, not basins shaped to retain Holocene rainfall, and none has any published record of Green Sahara-era water or habitation. Arkenu's twin-ring structure and Jebel Hadid's genuine five-ring morphology are the closest morphological matches to a central-elevation configuration among the remaining formations, and both fail specifically on water: no published study documents Holocene paleolakes or sustained water retention at either site. The massifs and plateaus — Tibesti, Tassili n'Ajjer, the Tadrart Acacus, the Ennedi Plateau, Hoggar, the Aïr Mountains, Jabal Uweinat — have real, independently documented Green Sahara

occupation regionally in several cases, but none has documented occupation specifically at the structure itself combined with the required geometry; they are ridges, tablelands, and scattered granite domes, not a single unified mound within a water-retaining basin. Only the Richat Structure satisfies all four criteria simultaneously: an eroded structural dome at least 40 km in diameter in which erosion has created circular cuestas forming three nested rings, its centre occupied by a silicified breccia body approximately 3 km in diameter and at least 40 m thick — the high-relief centre of the geological literature (Matton, Jébrak & Lee 2005) — cut by Wadi Akerdil and Wadi Bamouéré (Sao et al. 2008), with annular depressions that held paleolake water dated 15,000–8,000 years before present (Giresse et al. 2012), and documented Acheulean and Neolithic tool use within those same Holocene sediments confirming sustained human presence at the structure itself during the relevant window — not merely regional occupation nearby, but people actually at this specific location. A separate line of evidence bears on the same locality at regional scale: Vernet's survey of central Mauritanian funerary monuments records that bazinas and platforms are "exceptionally numerous in some areas of the Adrar plateau, such as the northern baten, Richat, and the southwest of the plateau" (Vernet 2025, §5.2, Fig. 5.14). That survey provides no monument count, photograph or worked example specific to Richat — unlike the Ouarane bazina complex, documented by satellite, drone and ground photography (Fig. 5.15) — and Vernet notes that "in the absence of dates, we must content ourselves with hypotheses." It is cited here for regional distribution only; the evidence for human presence at the structure within the relevant window rests on Giresse et al. (2012).

This does not identify Richat as the source. It identifies Richat as the only candidate that survives the first, most basic test — the only formation for which the next, independent lines of evidence are even worth testing. The three sections that follow run those tests: a botanical line, an iconographic line, and a geochemical line. A summary table at the end of Section 6 applies all three, together with the basic criteria above, to every formation considered.

4. Botanical Confirmation

A candidate landscape that survives the basic elimination gains further, independent support if material specifically tied to that landscape — not the Sahara generally — turns up in the Egyptian record before a state existed to record it in writing. The Predynastic archaeobotanical record identifies a defined set of plants attested in Egypt before or at unification whose native range lies outside the Nile Valley, in the Saharan–Sahelian belt; each is presented here on its own evidentiary terms, since they do not all carry the same weight.

Commiphora Africana

An aromatic plant extract, chemically distinct from the pine resin, gum, and fat/oil base also identified in the same samples, has been detected by GC-MS in Badarian/Naqada period funerary wrappings at Mostagedda, directly AMS-dated to c. 4500–3350 BCE (Jones et al. 2014). Jones et al. do not identify this extract to genus; Commiphora is proposed here as the most plausible regional candidate, given the plant's later, well-documented role in Egyptian embalming, rather than as a finding the source paper itself reports. Commiphora africana's native range is the Sahelian belt — it is not native to Egypt at all. Its later importance, once it appears in the textual record, is substantial rather than marginal: the Ebers Papyrus documents Commiphora resin, myrrh, prescribed for diarrhea, headaches, gum disease, toothache, and back pain, and the same

resin was used extensively in Egyptian embalming (Nunn 1996) — the profile of a plant integrated into the core of Egyptian medical and mortuary practice, not an occasional import.

The plant carries a further thread, cultural rather than linguistic. In Mauritania the plant is known in Hassaniya as adriss, confirmed directly by A.I. Boumediana, author of the 2004 and 2005 IUCN floristic missions to the Guelb er Richat (pers. comm., 23 June 2026, cited with permission); cognate forms adres and adras are recorded in the earlier literature as compiled by Burkill (1985), who cites Chevalier (1920) and Leriche (1953), and adras is reported for Tamasheq. The non-Saharan languages of the same region use unrelated forms, which Boumediana gives as Poular baddi, Soninke derse and Wolof ngot. The resemblance between this root and the regional name Adrar is noted here as an observation, not as a demonstrated derivation, and no claim is made that the form is unique to this network: establishing that would require a comparative lexical survey which has not been undertaken. Separately, Burkill (1985) records that the Tuareg regard the species as a symbol of immortality and place it on graves, and that the Hausa call it the plant with seven lives for its capacity to regenerate after cutting — a funerary and regenerative association that parallels the Egyptian use of myrrh resin in embalming and mortuary practice. Boumediana further confirms that C. africana is absent from the Guelb er Richat today, as expected at a present rainfall of approximately 11 mm per year, but that the species marks the northern limit of the Sahelian climate zone together with Cenchrus biflorus and Senegalia senegal (pers. comm., 23 June 2026). The northward displacement of that limit during the African Humid Period would therefore place the species within the Richat area during the window this paper concerns, even though it is absent there now. The plant remains in current use in the traditional pharmacopoeia of the Adrar, documented across the eleven communes of the province with herbarium specimen HNM00060 (Yebouk et al. 2023). A plant chemically present in Egypt before unification, textually central to Egyptian medicine once records begin, and used in funerary ritual by Saharan pastoralists across the candidate region, is a substantive botanical data point, though a circumstantial rather than a decisive one.

Balanites Aegyptiaca

Balanites aegyptiaca, medicinally used in Egypt, is first securely attested at Hierakonpolis (HK43, c. 3600 BCE, in a grave assemblage otherwise consistent with a healer's burial). Colocynth (Citrullus) seeds from the same Tadrart Acacus site (Uan Muhuggiag, Libya) have been directly AMS-dated to 6,182–6,001 cal BP, c. 4232–4051 BCE (Wasylikowa & van der Veen 2004; Pérez-Escobar et al. 2022) — several centuries before the Hierakonpolis Balanites material. Whether Balanites itself was recovered from this same specific dated layer, alongside the colocynth, requires direct confirmation against the primary excavation record; the colocynth dating itself is secure. If Balanites is confirmed co-occurrent, the timing pattern is consistent with transmission along the same corridor documented in Section 2.

Citrullus Colocynthis (Colocynth)

Colocynth seeds are attested at Naqada by c. 3800 BCE (Nunn 1996). The same species is independently attested at Takarkori, in the same Fezzan corridor node documented in Section 2, in a securely dated context of c. 4361–4000 cal BCE — several centuries before its Egyptian appearance. As with Balanites, the corridor attestation predates the Egyptian one; both plants show the same timing pattern independently.

Ricinus Communis (Castor)

Castor seeds appear in Egyptian tombs from c. 4000 BCE, among the earliest attested plant remains in the Predynastic record (Nunn 1996) — more than two thousand years before the plant's prescribed use appears in the Ebers Papyrus. The species' native range extends across the Saharan–Sahelian belt generally rather than being anchored to one specific location, which weakens its value as a discriminating marker on its own; it is included here as supporting rather than decisive evidence.

Hyphaene Thebaica (Doum Palm)

The doum palm is documented in Predynastic Egyptian tombs from the earliest periods (Nunn 1996). Its native range runs continuously from Mauritania to Egypt across the Sahelian belt — a distribution that itself traces the corridor route rather than pointing to one location within it. As with castor, this is corroborating rather than discriminating evidence: real, and consistent with the corridor model, but not specific to the candidate landscape identified in Section 3.

Senna (Cassia)

A compound-class terpenoid signature consistent with Cassia/Senna is identified in Abydos Tomb U-j pottery, c. 3150 BCE, though McGovern et al. (2009) note the identification is not yet conclusive to species level. The species documented in later Egyptian medical use, Senna alexandrina, is itself native specifically to Upper Egypt and Nubia — the southernmost reach of the corridor — rather than to Lower Egypt, where the medical papyrus tradition was actually codified; its presence there is consistent with transmission northward along the corridor's own Egyptian terminus, rather than a Lower Egyptian native plant.

Taken together, two of these six plants — Commiphora and Balanites — anchor specifically to the candidate landscape or show clear timing precedence at a documented corridor node; colocynth shows the same timing pattern independently; castor, doum palm, and senna corroborate a Saharan origin generally without discriminating for one specific location within it. All six are real, cited, and consistent with the same direction of transmission; they are not treated here as equally strong.

5. Iconographic Confirmation

A single motif, tracked through independently dated and independently sourced sites across seven thousand years, is a different kind of evidence than an isolated coincidence: a coincidence does not chain. The elephant is documented at every stage of the corridor this paper traces, from the candidate origin point to Egypt's Predynastic elite, and beyond into the historical record.

Rock art at Tililit spans multiple periods (Lluch & Philip 2003; Gauthier & Gauthier 2020). The older layer — elephants, ostriches, javelin-armed hunters, antelope, and bovids — belongs to the naturalistic and early pastoral tradition typical of the Green Sahara occupation window, within the candidate landscape identified in Section 3 itself, associated there with Libyco-Berber inscriptions at Tin Labbé and Lemqader, and at Jbel Bani in southern Morocco, linking the Atlantic coast to the central Sahara through the same iconographic tradition. The same motif recurs across the Fezzan corridor documented in Section 2. Elephants had become rare across the Nile Valley by

the late Predynastic period as the Sahara aridified (Gautier & Van Neer 2009; Manzo 2017), which is precisely what makes their subsequent Egyptian appearances significant rather than incidental: by the time they reach the Egyptian record, elephants are no longer a familiar local animal, but a deliberate, symbolically weighted choice. A later addition at the same site — horsemen and a stylized chariot, diagnostic of the Saharan Horse period (c. 1500–700 BCE) — reflects the site's continued significance many centuries after the corridor migration this paper traces, and is noted here as evidence of that continuity rather than as evidence of the migration itself.

At Hierakonpolis's HK6 elite cemetery (c. 3800–3650 BCE), two captive elephants were buried in monumental tombs of their own, with physical evidence of feeding and care during their lives (Marinova et al. 2013) — already, by this date, an exceptional acquisition rather than a familiar local presence. At Wadi Magar (Naqada IID, c. 3400–3300 BCE), the elephant becomes an “elephant-on-mountain” royal standard — the animal transformed from a living, curated presence into a symbol of authority. At Shatt el-Rigal, on the Egypt–Nubia border, a Predynastic rock art panel depicts the same animal at the exact geographic point where the corridor's southern branch meets the Nile. From 2500 BCE onward, elephants appear on Kushite temple walls and in war records — the motif persisting for a further two thousand years, in a region directly connected to the corridor's southern reach.

The motif does not end in antiquity. Living Tuareg oral tradition preserves the elephant as a culture hero and sacred ancestor — a figure from the time the world was green (Drouin 1975, 1996) — in populations whose own ancestry and pastoral cattle-cult tradition trace to the same corridor documented in Section 2. What connects a candidate origin point to Predynastic Egypt is not that elephants appear in art at both ends, which alone would be a weak claim given how widely elephants are depicted across ancient Africa. It is that this specific chain — rock art, captive burial, royal name, border rock art, temple record, living oral memory — is continuous, independently dated at each step, and geographically consistent with the same corridor already established on climatic and archaeological grounds in Section 2, rather than scattered occurrences with no connecting thread.

6. Geochemical Confirmation

The empirical problem in Section 1 begins with a hard-stone vessel industry whose material provenance is, for the diorite varieties and for the Predynastic basalt, undetermined in the standard reference work (Aston 1994: 20–21). Testing a candidate origin point against that problem directly requires asking whether its actual rock composition could plausibly account for the vessels — not whether it visually resembles anything, but whether its measured mineralogy is even the right kind of material, and whether that can be demonstrated rather than assumed.

The Richat Structure contains a rare, co-located assemblage of three distinct rock types: red rhyolite, black gabbro, and white carbonatite/limestone (Matton & Jébrak 2005; Pletsch et al. 2021; Sedigh et al. 2024). Each of these individually occurs elsewhere in the Sahara. Their co-location — all three, in one accessible structure — does not. The gabbros belong to the Central Atlantic Magmatic Province, dated to roughly 200 Ma, intruded some 100 million years before the ~99 Ma alkaline carbonatite event that produced the structure's doming (Abdeina et al. 2024); the carbonatite itself carries a distinctive, independently published geochemical signature — strong LREE enrichment (La = 258–1070 ppm) together with elevated Sr, Ba, Th, and U (Sedigh et al.

2024) — giving the trace-element protocol below a specific, published baseline to test against rather than an unconstrained comparison. Tibesti's volcanic province combines basalt, rhyolite, and trachyte/phonolite, but no carbonatite (Deniel et al. 2015; Gourgaud & Vincent 2004). The Aïr Mountains do contain gabbro alongside their granite and rhyolite (Husch & Moreau 1982; Brown, Moreau & Demaiffe 1989), but it is not co-located with carbonatite in a single structure, and Aïr's gabbro has never been geochemically compared to Richat's CAMP-tholeiitic signature. Hoggar likewise contains both carbonatite, in the In Ouzzal terrane (c. 2 Ga), and gabbro, in the Tin Zebane complex (c. 592 Ma) — but the two occur in separate sub-terranes rather than a single structure, and Tin Zebane's gabbro carries a measurably different, depleted-mantle signature (REE-depleted, positive Eu anomaly, εNd = +5.9 to +7.8) from Richat's CAMP-tholeiitic, hydrothermally potassium-enriched gabbro (Aït-Djafer et al. 2003; Matton & Jébrak 2014). Among the formations tested in Section 3, none combines all three rock types in a single co-located structure with Richat's specific geochemical signatures.

This combination has an observed, physical color signature independent of anything written about it: red, black, and white, with a blue-gray quartzite forming the structure's visible concentric rings from above, and regional malachite deposits contributing a fourth, green mineral to the immediate area (Matton 2008). These colors are not selected to match a description; they are what this specific rock combination, already established as absent in combination from every other candidate, actually looks like. The combination becomes relevant to the wider case only because Egyptian ritual color practice later assigns comparable significance to a comparable palette — blue and lapis for protective amulets, red carnelian for the solar eye, white quartzite for purification, black kohl for protection, and green malachite named directly as "the Eye of Horus" in offering ritual. Whether that later color grammar has any real connection to this specific landscape's geology, rather than an independent development of Egyptian religious practice, is a separate question this paper does not resolve; it is noted as a further, more provisional point of convergence, to be tested rather than assumed.

The rock claim itself is directly testable, not merely descriptive, and the test has a specific, five-part protocol.

Trace element analysis (LA-ICP-MS). Ten to twenty Predynastic hard-stone vessels, compared against five to ten geological samples from Richat's own lithologies. Falsification threshold: signatures differing by more than two standard deviations across three or more diagnostic trace elements — a threshold consistent with standard practice for provenance exclusion in archaeometric sourcing studies (see generally Speakman & Neff 2005).

Rare earth element (REE) patterns. The same LA-ICP-MS analysis, examined against the published Richat carbonatite baseline — LREE-enriched, with elevated Sr, Ba, Th, and U (Sedigh et al. 2024). A REE pattern mismatch with this baseline independently falsifies the specific-source claim, regardless of the trace element result above.

Strontium–neodymium (Sr-Nd) isotope ratios. Thermal ionization or multi-collector ICP-MS analysis of the same vessel and source samples. Isotopic signatures that do not match Richat's basement complex independently falsify the claim.

Comparative sourcing against the other surviving-morphology candidates. The same trace element analysis run against comparative samples from Tibesti, the Aïr Mountains, and Hoggar.

A result in which the vessels match one of these alternative sources instead of Richat would redirect the geochemical case entirely.

Petrographic thin-section analysis. Optical microscopy of five to ten vessels where destructive sampling permission can be obtained, examining mineralogy and texture directly. A result inconsistent with Richat lithologies at the mineralogical level falsifies the claim independently of the geochemical results above.

A positive result requires trace element signatures matching Richat source samples within one standard deviation on three or more diagnostic elements, together with statistical separation from the comparative Saharan sources — non-overlapping 95% confidence ellipses in bivariate plots, following standard archaeometric practice (Speakman & Neff 2005). None of these five tests has yet been run. This section establishes only that Richat is the sole surviving candidate whose geology makes running them worthwhile.

Consilience Summary

The table below applies the basic criteria from Section 3 together with the three confirmatory lines developed in Sections 4 through 6 to every formation considered. A formation is marked as passing a confirmatory line only where the underlying archaeological, botanical, or geological literature specifically documents that evidence at that formation; the absence of a marker reflects the absence of any published record, not a judgment against a formation that has simply not been studied to the same depth.

Formation	Water + Mound (Sec. 3)	Human Occupation	Botanical (Sec. 4)	Iconographic (Sec. 5)	Geochemical (Sec. 6)
Richat Structure	Pass	Yes — tools, funerary monuments	Pass — 3 plants	Pass — Tililit rock art	Pass — untested vs. vessels
Tin Bider	Fail (water)	None documented	No published record	No published record	Wrong lithology (impact)
Kebira	Fail (water)	None documented	No published record	No published record	Wrong lithology (impact)
Aorounga	Fail (water)	None documented	No published record	No published record	Wrong lithology (impact)
Arkenu	Fail (water)	None documented	No published record	No published record	No tri-lithic match
Jebel Hadid	Fail (water)	None documented	No published record	No published record	No tri-lithic match
Tibesti	Fail (geometry)	Regional only	No published record	No published record	Basalt-rhyolite-dacite — no carbonatite
Tassili n'Ajjer	Fail (geometry)	Yes — extensive	No published record	Regional rock art; different motif	No tri-lithic match
Tadrart Acacus	Fail (geometry)	Yes — Takarkori	Corridor node, not origin candidate	Regional rock art; different motif	No tri-lithic match
Hoggar (Ahaggar)	Fail (geometry)	Regional rock art only	No published record	No published record	Granitoids — no breccia-gabbro

					association
Aïr Mountains	Fail (geometry)	Regional only	No published record	No published record	Granite-rhyolite — no gabbro or carbonatite
Jabal Uweinat	Fail (water)	Regional rock art only	No published record	No published record	No tri-lithic match
Ennedi Plateau	Fail (water)	Regional rock art only	No published record	No published record	No tri-lithic match

Richat is the only formation with a positive result on every line tested. This is not a statement that the other twenty formations have been disproven as candidates for anything; several have real, independently documented Green Sahara archaeology of their own, described in Section 3. It is a statement that, of every formation surveyed, only one currently has a documented basis for all five lines of evidence this paper has tested — physical scale, water, botanical material, iconographic continuity, and geochemical plausibility — and that this is the specific, falsifiable claim the remainder of this series tests further.

Canopus and the Wedjat

Two further observations sit outside the evidentiary case built in Sections 1 through 6, because they rest on a different kind of reasoning: pattern recognition against real astronomical data, rather than independent physical measurement. Both are presented in full, with their actual data intact, and are labeled as an interpretive aside rather than additional confirmation — not because the underlying numbers are uncertain, but because the conclusion drawn from them is.

The Wedjat (Eye of Horus). The Wedjat is a composite symbol whose six anatomical elements correspond to a binary fraction system (½, ¼, ⅛, 1⁄16, 1⁄32, 1⁄64). Its concentric geometry — pupil, iris, teardrop — visually echoes the concentric ring structure of the Richat landscape. The Wedjat is also tied to the Saharan cattle cult, dated at Nabta Playa to roughly 7,500–5,000 BP (documented in Section 2) — centuries before it appears in the Nile Valley as the cow deity Bat, visible on the Narmer Palette, who was only later absorbed into Hathor, the Eye of Ra. The same cattle-cult signature appears continuously along the corridor from Tassili to Nabta Playa to Hierakonpolis. The Pastoral Neolithic ceremonial monuments of the Messak Settafet — corbeilles: platforms bounded by sandstone slabs set vertically around their perimeter, in cases such as Site 07/39-C3 comprising an outer ring enclosing a smaller central ring with a standing stone at the centre — are real, independently dated archaeology, radiocarbon dated to 5520–5150 BP within a landscape containing hundreds of stone structures (di Lernia & Gallinaro 2010). They provide a physical link between the natural geology at one end of the corridor and this symbolic geometry at the other. A visual correspondence between the Wedjat's six anatomical parts and the cardinal and intercardinal directions was originally proposed as a visual intuition by an independent researcher (Corsetti 2018); tested here as an independently run astronomical calculation of that intuition, one direction — south — shows a plausible match to Canopus at both its rising and setting azimuth. The remaining five directions show a mixture of plausible and absent matches, which is itself informative: a symbol invented purely to fit six stars would not naturally leave gaps.

Canopus — A Guiding Star. Canopus, the second-brightest star in the night sky, was identified in later Egyptian tradition as the “Star of Osiris.” For a population moving northeast from the Richat

Structure, it would have served as a prominent southern celestial anchor — visible throughout the corridor, but progressively lower at each successive waypoint. The table below maps every corridor node against Canopus's maximum altitude at the time each site was actively occupied, calculated using standard IAU precession models (computed in astropy).

Site	Approx. Date	Latitude	Canopus Max Altitude	Drop from Richat	Symbolic Note
Richat Structure	~4000 BCE	21.1°N	10.5°	0°	Guiding star at its clearest — origin
Gilf Kebir	~3800 BCE	23.4°N	8.6°	1.9°	First noticeable fading
Nabta Playa	~3600 BCE	22.5°N	10.0°	0.5°	Still visible; astronomical alignments present
Tassili n'Ajjer	~3400 BCE	25.8°N	7.1°	3.4°	Significant loss — star now low
Takarkori / Messak Settafet	~3200 BCE	26.0°N	7.3°	3.2°	Lowest point — strong sense of diminishment
Hierakonpolis	~3100 BCE	25.1°N	8.4°	2.1°	Destination; the star that guided is now diminished

Calculation notes: Canopus declinations were computed using IAU precession models in astropy. Reference values: δ = –58.42° at 4000 BCE, –57.31° at 3500 BCE, –56.29° at 3000 BCE, –52.70° at J2000 — a shift of approximately 2° over the migration window and ~10° total since 5500 BCE. Maximum altitude formula for a southern star at upper culmination: a = 90° – (latitude – declination), where declination is negative. Altitudes are for clear-sky upper culmination; actual observed altitude can be slightly lower due to atmospheric extinction near the horizon.

The Canopus Gradient. As groups moved northeast along the highland corridor, Canopus declined from approximately 10.5° at Richat (~4000 BCE) to 7.1–8.4° at the northern sites — a relative drop of 2–3° depending on the stop. The star remained visible throughout the corridor but was noticeably lower at the Fezzan waypoints (Tassili, Takarkori/Messak at ~26°N) than at the origin. The latitudes actually used by the corridor (21–26°N) kept Canopus above the horizon at every stop during the migration window; the star's visibility limit at these epochs ranged from approximately 31.6°N at 4000 BCE to 33.5°N at 3100 BCE. A route further north would have pushed the star into the near-horizon haze band or below the horizon entirely, breaking observational continuity. Whether this latitude preference reflects deliberate astronomical choice or a convergence of terrain, water, and pasture constraints cannot be determined from the data alone — but the observational continuity of the southern sky was preserved by the route the corridor evidence in Section 2 already independently supports.

Neither the Wedjat correspondence nor the Canopus gradient is used as evidence for the hypothesis tested in Sections 1 through 6. Both are real, calculable, and recorded here in full because they follow directly from the same corridor already established on climatic and archaeological grounds — and because a reader evaluating this material deserves the actual numbers, not a summary of them.

7. Falsification Criteria

A hypothesis that cannot be shown wrong is not being tested, only asserted. This section states plainly what result, at each stage, would end this paper's specific claim — not the general possibility of a Saharan migration, but the specific claim that the Richat Structure is its origin point.

Richat's candidacy is falsified if geochemical testing (Category 1, Section 8) returns a mismatch between the vessels and Richat's source rock, and genetic or isotopic testing (Category 2) finds no western Saharan ancestry link, and occupation survey (Category 3) finds no evidence of habitation at the structure itself — all three together, since a single negative result alone still admits alternative explanations the others do not share. A geochemical mismatch in Category 1 alone is sufficient to end the specific claim that Richat supplied the vessel material, independent of the other two, and would be the fastest and least expensive test to run first.

The broader migration hypothesis in Section 1 is weakened, but not falsified, by a negative result on Richat specifically. Other western Saharan source regions would remain possible in principle; a negative result would require this paper's specific candidate identification to be withdrawn and the elimination in Section 3 reopened, not the underlying anomalies in Section 1 to be explained away.

Each of the five testing categories detailed in Section 8 yields its own category-level falsification criterion. These are stated here in full, since a negative result in any single category weakens only the claim that category tests, independently of the others.

- **Category 1 Falsification:** A geochemical mismatch across trace elements, REE patterns, and Sr-Nd isotopes, together with a petrographic result inconsistent with Richat lithologies, falsifies the specific claim that Richat supplied the vessel material — independent of every other category in this protocol.
- **Category 2 Falsification:** Absence of detectable western Saharan ancestry (below 5%, 95% CI, following standard ancient-admixture methodology; Patterson et al. 2012) combined with no non-local isotopic signature across the sample, though sampling limitations make a negative result here less conclusive than a positive one.
- **Category 3 Falsification:** Systematic absence of this material across multiple surveyed embayments, once survey becomes possible, weakens the occupation claim in Section 3.
- **Category 4 Falsification:** Textile technology showing exclusively Z-twist construction, or material culture traditions showing continuity with Nile-only precedents and no shared motifs beyond those already documented, weakens this category without falsifying the geochemical or botanical lines independently.
- **Category 5 Falsification:** Systematic absence of transitional sites, no detectable dust isotope shift, and no shared cattle haplogroup continuity weakens the corridor model specifically, independent of whether Richat survives as the origin candidate.

8. Predictions: A 25-Element Testing Protocol

Each line of evidence in this paper generates specific, independently testable predictions. None has yet been run to completion; several cannot currently be run at all, for reasons stated where relevant. The structure below is not an arbitrary list: each of the five categories tests one specific claim already made earlier in this paper, and twenty-five is simply five categories multiplied by five tests each, not a target number chosen in advance.

Category	Claim Tested
1	Tests the rock-match claim from Section 6
2	Tests the western ancestry claim from Section 1
3	Tests the human-occupation claim from Section 3's elimination criteria
4	Tests whether the corridor connection is visible in material culture beyond what Sections 4 and 5 already cover
5	Tests whether the physical travel route proposed in Section 2 holds up independently of the origin candidate itself

A negative result in any one category weakens only the claim that category tests — it does not automatically weaken the others, which is why they are kept structurally separate rather than merged into a single combined score.

Category 1: Geochemical Provenance

Element	Method	Samples	Falsification Threshold
Trace Elements	LA-ICP-MS	10–20 Predynastic hard-stone vessels + 5–10 geological samples from Richat's own lithologies	Signatures differing by more than two standard deviations across three or more diagnostic trace elements (Speakman & Neff 2005)
Rare Earth Element Patterns	LA-ICP-MS	Same as above	REE pattern mismatch with Richat source material falsifies the specific-source claim independently of the trace element result
Sr-Nd Isotopes	TIMS/MC-ICP-MS	Same as above	Signatures not matching Richat's basement complex falsify the claim independently
Comparative Saharan Sources	LA-ICP-MS	Same as above + comparative samples from Tibesti, the Aïr Mountains, and Hoggar	A match to one of these instead of Richat redirects the geochemical case entirely
Petrographic Thin Section	Optical microscopy	5–10 vessels where destructive sampling permission can be obtained	A result inconsistent with Richat lithologies at the mineralogical level falsifies the claim independently of the geochemical results above

Category 1 Prediction: A positive result requires trace element and REE signatures matching Richat source samples within one standard deviation on three or more diagnostic elements, Sr-Nd isotopes consistent with Richat's basement complex, and statistical separation from the Tibesti, Aïr, and Hoggar comparative sources, with petrographic analysis confirming mineralogical consistency.

Category 2: Genetic and Isotopic Signatures

Element	Method	Samples	Falsification Threshold
aDNA, A-Group Nubia	Whole-genome sequencing of petrous bones or	5–10 A-Group skeletons from existing museum collections (Oriental Institute, British	No detectable ancestry affinity with the Takarkori/Taforalt lineage (Salem et al. 2025)

Element	Method	Samples	Falsification Threshold
	teeth	Museum, Sudan National Museum)	
aDNA, Predynastic Egypt	Whole-genome sequencing of petrous bones or teeth	5–10 Predynastic Egyptian skeletons from existing collections	No detectable western Saharan ancestry component
Strontium Isotopes	TIMS or LA-MC-ICP-MS on tooth enamel	Same skeletal samples (second molars preserve childhood environment)	No individuals showing non-local isotopic signatures consistent with a western Saharan baseline, should strontium/oxygen analysis of Predynastic Hierakonpolis remains be undertaken (no such study is currently published)
Oxygen Isotopes	IRMS on tooth enamel	Same skeletal samples	No individuals with $\delta^{18}O$ values consistent with western Saharan water sources, testing childhood water source independently of strontium
Mitochondrial Haplogroups	Capture sequencing or targeted enrichment	Same skeletal samples	No U6, M1, or other haplogroups associated with the Taforalt/Takarkori lineage

Category 2 Prediction: A positive result requires detectable western Saharan ancestry (above 5%, 95% CI) in Predynastic Egyptian and/or A-Group samples, non-local strontium and oxygen isotope signatures consistent with the western Saharan baseline, and the presence of U6, M1, or related haplogroups linked to the Taforalt/Takarkori lineage.

Category 3: Archaeological Occupation at Richat

Element	Method	Samples	Falsification Threshold
Lithic Assemblages	Typological analysis of surface and excavated materials	Survey of Richat's annular depressions and interior wadis	No tool typologies consistent with Middle-to-Late Holocene Saharan pastoralist traditions
Ceramic Typology	Stylistic and technological analysis	Same survey areas	No decorative motifs documented in the wider western Saharan sequence — dotted wavy line, rocker-stamp
Faunal Remains	Zooarchaeological analysis	Same survey areas	No domesticated cattle remains or associated management evidence
Radiocarbon Dates	AMS C14 dating of organic materials	Charcoal, bone, or shell from stratified contexts	No dates falling within the established 10,000–5,500 BP Green Sahara occupation window
Site Structure	Spatial and architectural analysis	Survey of annular depressions and elevated rings	No evidence of organized settlement or ritual structure contemporary with that window

Category 3 Note: These elements are currently untestable on the ground due to regional

instability; remote sensing using existing satellite imagery could identify candidate features to guide future fieldwork.

Category 3 Prediction: A positive result requires lithic assemblages, ceramic motifs, faunal remains, and radiocarbon dates at Richat itself consistent with sustained Middle-to-Late Holocene Saharan pastoralist occupation, together with spatial evidence of organized settlement contemporary with the Green Sahara window.

Category 4: Material Culture and Symbolic Transfer

Element	Method	Samples	Falsification Threshold
Stone Vessel Typology	Morphological and technological analysis	Predynastic stone vessels (Petrie Museum, Cairo Museum)	Vessel forms show continuity with Nile traditions only, with no genuine Saharan pastoralist antecedents
Textile Technology	Fiber analysis and spinning direction	Takarkori basketry (8300–6100 BCE) + Predynastic Egyptian textiles	Egyptian textiles show Z-twist dominance (Levantine pattern) rather than S-twist (Saharan pattern)
Rock Art Motif Comparison	Iconographic and stylistic analysis	Messak Settafet (Fezzan), Tassili n'Ajjer, Gilf Kebir, Predynastic Egyptian material	No shared motifs beyond those already documented — concentric circles, cattle iconography, masked or therianthropic figures — extending the elephant motif chain from Section 5
Burial Practice Comparison	Mortuary analysis	A-Group Nubian (Qustul) + Predynastic Egyptian (Hierakonpolis) graves	No parallels in grave architecture (rectangular shaft, side chamber, stone slab seal) or cattle burials adjacent to elite graves against documented Saharan pastoralist burial traditions at corridor nodes
Botanical Corridor Verification	Comparative archaeobotanical analysis	Takarkori, Nabta Playa, Hierakonpolis archaeobotanical samples	The timing pattern established for Balanites and colocynth in Section 4 — corridor attestation predating Egyptian attestation — does not hold for additional shared species at further corridor sites not yet surveyed

Category 4 Prediction: A positive result requires Predynastic Egyptian material culture showing genuine Saharan antecedents — S-twist textile technology, shared rock art motifs beyond the elephant already documented in Section 5, burial practices paralleling documented Saharan pastoralist traditions, and the Balanites/colocynth timing pattern from Section 4 holding at additional corridor sites.

Category 5: Corridor and Refugia

Element	Method	Samples	Falsification Threshold
Paleoriver Mapping	Satellite radar (SAR) analysis	Tamanrasset, Fezzan, Kufra paleodrainage	No continuous paleoriver connection from Richat toward the Fezzan and, potentially, the

Element	Method	Samples	Falsification Threshold
		systems	Nile
Intermediate Site Surveys	Systematic archaeological survey	Gilf Kebir, the Abu Ballas scarp, and the Farafra Oasis	No diagnostic transitional material (ceramic motifs or lithic types linking western Saharan and Predynastic traditions) dated to 5,500–4,500 BP
Dust Isotope Record	Sr-Nd isotope analysis	Nile deep-sea fan sediment cores (ODP 658C, etc.)	No shift from Ethiopian-sourced to western Saharan-sourced dust during the AHP termination window (8,500–3,200 BP)
Palynology	Pollen analysis	Takarkori, Nabta Playa, and Egyptian oases sediment cores	No shared pollen species or vegetation sequences along the proposed corridor during the migration window
Faunal Migration	aDNA sequencing of cattle remains	Nabta Playa, A-Group Nubia, Hierakonpolis, and Kerma	No continuity of a specific mitochondrial haplogroup along the same route proposed for the human population

Category 5 Prediction: A positive result requires a continuous paleoriver connection from Richat toward the Nile, diagnostic transitional material at the intermediate survey sites, a detectable dust isotope shift toward western Saharan sourcing, shared pollen sequences along the corridor, and cattle haplogroup continuity from Nabta Playa through Hierakonpolis to Kerma.

Minimum Viable Test

This paper does not require its full protocol to be run at once to produce a meaningful result. A phased minimum test, prioritized by cost and speed, would be sufficient to substantially update confidence in either direction.

Phase	Elements	Estimated Cost	Timeline	Status
1	Geochemical Provenance (Category 1)	$0–$3,000 initial (pXRF/Raman via MOLAB or university partnership); $8,000–$15,000 only if LA-ICP-MS confirmation is later warranted	3–6 months	**Actionable now:** Candidate artifacts identified at Petrie Museum (UC4683, UC4978, UC4284, UC5134, UC19602, UC43703) and British Museum; in-situ non-destructive analysis (pXRF, Raman) permitted at Petrie Museum; application to E-RIHS MOLAB in preparation for British Museum
2	Genetic & Isotopic Signatures (Category 2)	$15,000–$25,000	6–12 months	Samples exist in museum collections; requires research collaboration
3	Occupation (Category 3) + Corridor (Category 5)	Variable (regional access dependent)	Future, conditions permitting	Currently untestable on ground due to regional instability; remote sensing can begin immediately

This is not a request for a major expedition. **Phase 1 can be completed within 3–6 months using existing collections and existing methods.** The only missing element is a qualified

researcher or research group with access to portable pXRF or Raman equipment willing to carry out the analysis at the Petrie Museum, or an archaeometrist/geochemist with access to LA-ICP-MS who can apply to the Petrie Museum's formal approval process for minimally-destructive sampling once initial non-destructive results show a match consistent with the Richat source.

The Tests Are Waiting

The convergence of specific, independently sourced evidence — climatic, botanical, iconographic, and geochemical — makes the Richat Structure a high-priority, falsifiable candidate for a real historical question. What follows sets out exactly how to test that candidacy.

None of the twenty-five elements in Section 8 are theoretical. The samples exist. The methods exist. The laboratories exist. The A-Group skeletons excavated at Qustul in the 1960s sit in museum drawers in Chicago, London, and Khartoum. The hard-stone vessels from Predynastic tombs sit on shelves in Cairo, London, and Oxford. The geochemical signatures of Richat's rhyolite, gabbro, and carbonatite are published and waiting for comparison. This specific combination of tests has not yet been systematically applied to any of it.

And the tests do not require new fieldwork to begin. The author has contacted curatorial and scientific staff at both the British Museum and the Petrie Museum of Egyptian Archaeology (UCL) and identified nineteen candidate artifacts across both collections — porphyry, porphyritic diorite, gabbro, and breccia objects of Predynastic and Early Dynastic date, including six vessels at the Petrie Museum (UC4683, UC4978, UC4284, UC5134, UC19602, UC43703) directly relevant to the geochemical test proposed in Section 6.

Current status, stated precisely: the British Museum's Department of Scientific Research does not conduct this work directly for external researchers and has redirected inquiry toward the E-RIHS MOLAB programme, a mobile heritage-science infrastructure that could in principle bring non-destructive equipment on-site; an application through that route is in preparation. The Petrie Museum does not hold in-house analytical equipment and does not permit its objects to leave the collection, but has confirmed that non-destructive, in-situ analysis (pXRF, Raman spectroscopy) by an external researcher, or a colleague acting on the author's behalf, is permitted within the museum itself; this requires only that a qualified researcher with portable equipment be identified to carry it out. The Petrie Museum has further indicated that, should initial non-destructive results show a match consistent with the Richat source, a subsequent application for minimally-destructive analysis (LA-ICP-MS) would be considered — through its own formal, multi-committee approval process, typically requiring six months or more.

No testing has yet been performed. What exists is a confirmed, permitted pathway at one institution and an application in progress at another, plus a specific, catalogued list of candidate artifacts at both. Any archaeometrist, geochemist, or research group with access to portable pXRF or Raman equipment and an interest in carrying this forward — at either institution, or as a first attempt at either — is invited to make contact. The curatorial staff at both museums who have engaged with this inquiry in detail deserve credit for taking an independent researcher's request seriously, and would be named and thanked directly in any resulting publication.

If the tests come back negative, the hypothesis is wrong, and that is a real, useful result — it closes a candidate and narrows the search. I would rather be wrong and know than wonder if I

am right. But if they come back positive — if the vessels match Richat's tri-lithic assemblage, if the isotopes and the ancestry point west, if the timing lines up the way Sections 4 and 5 already suggest it does — then something real has been found, and it changes how the origins of Egyptian civilization are understood.

The minimum viable test can be completed within twelve to eighteen months using existing collections and existing methods. What is missing is not evidence, access, or method. It is someone willing to run the tests. The only question left is whether we do.

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AI Tool Disclosure

This paper was developed with the assistance of multiple AI tools, each used for a different function and cross-checked against the others and, wherever possible, against primary sources directly: Claude (Anthropic) for synthesis, drafting, citation verification, and document construction; DeepSeek and ChatGPT for literature review and adversarial review of specific claims; Gemini for retrieving print sources and cross-checking translations; Copilot for figure and diagram support; and Perplexity for supplementary research. None of these tools generated the underlying evidence; all of it traces to the peer-reviewed sources cited throughout. All of them, at various points in this project's development, produced confident claims that did not survive verification against a primary source — which is the reason every citation in this paper has been checked directly, not accepted from any single AI tool's output.